SGD-O

Non-Contacting Density Gauge
For Fracturing & Cementing
User Guide
P/N 717910

Revision D

Part of Thermo Fisher Scientific

Thermo SCIENTIFIC

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Thermo
SCIENTIFIC

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Revision History

Revision Level	Date	Comments
A	10-2007	Initial release (ERO 5984).
B	04-2008	Revised per ECO 6268.
C	04-2008	Revised per ECO 6298.
D	01-2012	Revised per ECO 7896.

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Safety Information

This chapter contains information that must be read and understood by all persons installing, using, or maintaining this equipment.

Safety Considerations

Failure to follow appropriate safety procedures or inappropriate use of the equipment described in this manual can lead to equipment damage or injury to personnel.

Any person working with or on the equipment described in this manual is required to evaluate all functions and operations for potential safety hazards before commencing work. Appropriate precautions must be taken as necessary to prevent potential damage to equipment or injury to personnel.

The information in this manual is designed to aid personnel to correctly and safely install, operate, and/or maintain the system described; however, personnel are still responsible for considering all actions and procedures for potential hazards or conditions that may not have been anticipated in the written procedures. **If a procedure cannot be performed safely, it must not be performed until appropriate actions can be taken to ensure the safety of the equipment and personnel.** The procedures in this manual are not designed to replace or supersede required or common sense safety practices. All safety warnings listed in any documentation applicable to equipment and parts used in or with the system described in this manual must be read and understood prior to working on or with any part of the system.

Failure to correctly perform the instructions and procedures in this manual or other documents pertaining to this system can result in equipment malfunction, equipment damage, and/or injury to personnel.

Safety Summary

The following admonitions are used throughout this manual to alert users to potential hazards or important information. **Failure to heed the warnings and cautions in this manual can lead to injury or equipment damage.**

Warning Warnings notify users of procedures, practices, conditions, etc. which may result in injury or death if not carefully observed or followed. The triangular icon displayed with a warning may contain a lightning bolt or the radiation symbol, depending on the type of hazard. ▲

Caution Cautions notify users of operating procedures, practices, conditions, etc. which may result in equipment damage if not carefully observed or followed. ▲

Note Notes emphasize important or essential information or a statement of company policy regarding an operating procedure, practice, condition, etc. ▲

Chapter 1
Product Overview

Introduction

The Thermo Scientific SGD-O system consists of a radiation source in a lead-filled housing, an ion chamber detector with an amplifier, and the SGD-O transmitter. The transmitter processes the detector signal to provide a signal output proportional to the density of the slurry, the mass of solids added per volume of carrier, or both. This instrument is dedicated to fracturing operations (fracing); therefore, this manual will describe the setup for fracing applications only.

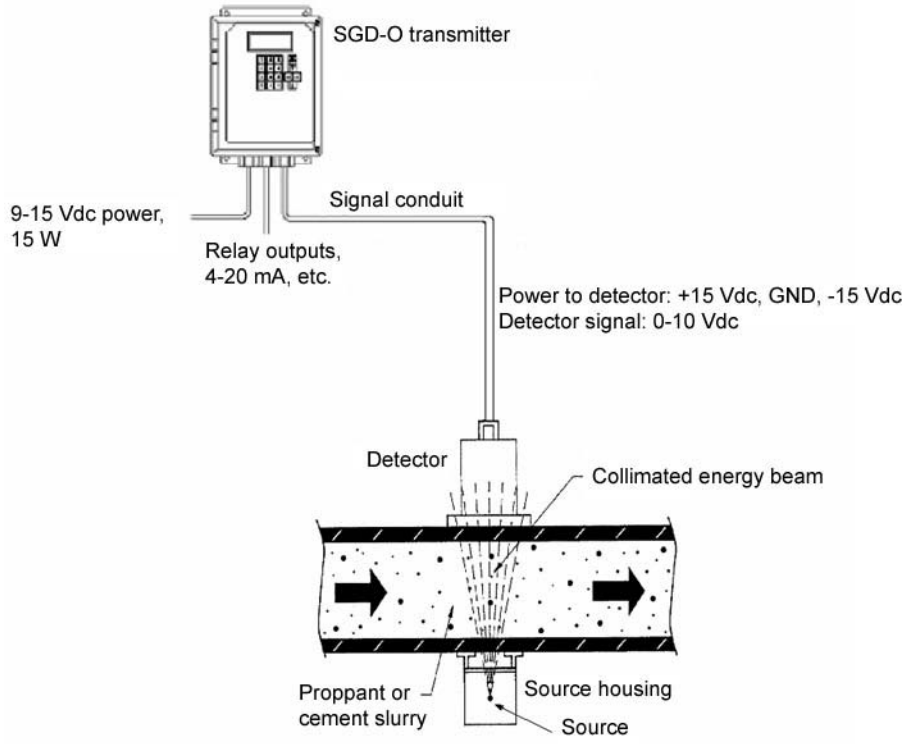

Figure 1–1. Typical system

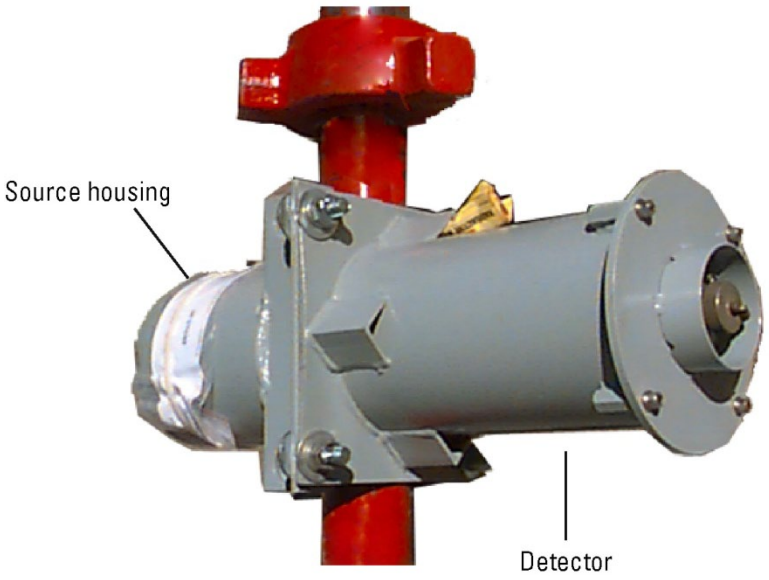

Figure 1–2. Example of a shutterless unit installed on a high pressure pipe

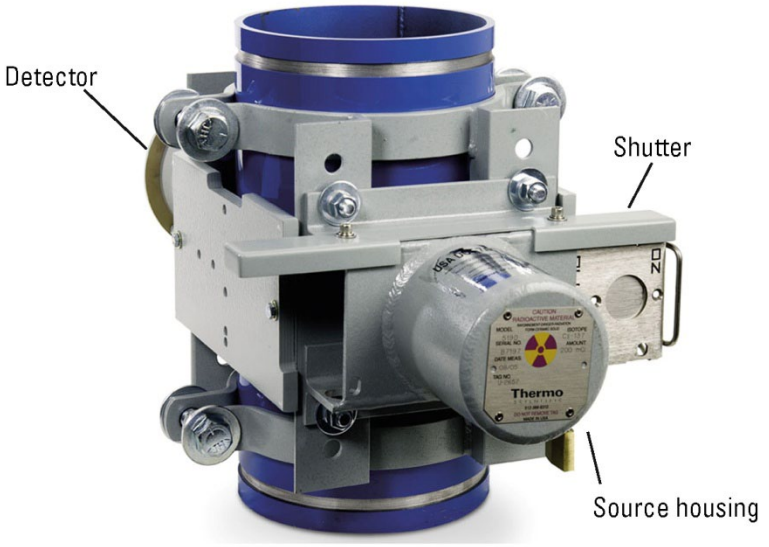

Figure 1–3. Example of a unit with shutter (low pressure application)

The Gamma Source

The source head contains the gamma source. The gamma radiation is emitted naturally by a radioactive material. Mostly Cesium-137 (Cs-137) is used for this application. The radioactive material is first bound in a glass or ceramic matrix and encapsulated in a stainless steel cylinder that is welded closed and tested for leakage. This capsule is placed inside another cylinder of stainless steel that is also welded closed. This double encapsulation ensures that the source material will remain contained even under extreme conditions of use. The source capsule is then secured in the center of the housing.

The radiation hazard of the gauge is minimized by its construction. The source housing is a rugged, circular steel cylinder that is filled with lead except in the direction of the beam path. The lead is designed to reduce the radiation level outside the housing to a relatively low level. The gamma ray beam is therefore collimated in the direction of the detector.

There are two source housing models primarily used for this application:

- Model 5192: This source housing typically does not have a shutter. It is welded to a high pressure pipe and designed to handle high vibration applications. For the source head without a shutter, the back of the detector is designed with extra metal thickness to allow the radiation beam to be reduced to a safe level outside the detector assembly for transportation purposes.
- Model 5190: This source housing has a sliding shutter with three positions: ON, OFF, and CAL. The purpose of the shutter is to block the radiation beam when it is placed in the OFF position.

Due to the precautions taken during manufacture, the chance of leakage is remote. However, the United States Nuclear Regulatory Commission (NRC) requires that the source housing be leak tested at regular intervals, not to exceed three years. Canadian regulations require that leak test intervals not exceed one year. Refer to the Gamma Radiation Safety Guide (p/n 717904) for further information. Thermo Fisher is licensed to perform these tests and can do so through contract services. The first test or “wipe” is done by licensed personnel or prior to shipment from the factory.

If the source housing is damaged or the system is abandoned, the source housing must be disposed of properly. Regulations for the NRC, U.S. Department of Transportation, and the Canadian Nuclear Safety Commission are continuously being updated; contact Thermo Fisher Scientific for information on proper source disposal.

The Detector

The collimated radiation beam goes through the pipe and process material where it is attenuated by the slurry. The attenuation is dependent on the bulk density of the process material. The attenuated beam reaches the detector on the other side of the pipe where it is measured.

The detector is made of an ion-chamber sensitive to gamma radiation. The chamber is a small tank filled with pressurized gas. A high voltage is supplied between the wall of the chamber and a central isolated electrode. The interaction of the gas and the gamma rays ionizes the gas whose charge is collected at the central electrode. The output of the ion chamber is therefore a very small current (picoamp = 10^{-12} amp) proportional to the radiation that reaches it. That current is amplified by the detector electronics to a measurable voltage in the range of 0–10 Vdc. This output voltage is sent to the transmitter for processing.

The Transmitter

The SGD-O transmitter is a microprocessor-based system that processes the signal from the detector (0–10 Vdc) to provide an output signal (4–20 mA) representing the amount of solids (proppant) added per volume unit of carrier and/or the bulk density of the slurry. It monitors system performance and generates system fault and warning alarms as well.

The integral keypad on the transmitter is normally used as the primary means of communication with the instrument. Menu selections, commands, and parameter values are entered using the keypad. The transmitter has a four-line display that shows either one menu item or up to eight readouts in alternation (four at a time).

An RS232 serial port can also be used to communicate with the instrument using a PC with terminal emulation software.

Inputs & Outputs

The characteristics of the input and output options for the gauge are summarized in the following table.

Table 1–1.

Type	Characteristics	Comments
Transmitter input power	DC power: Standard: 12 Vdc (9–15 V), 15 W Optional: 24 Vdc (20–28 V), 12 W AC power: Optional: 110/220 Vac (100–240 V), 50/60 Hz, 25 VA	
Current output	3.8–20.5 mA DC (adjustable operating range) Standard configuration: - Isolated, self-powered, 700 ohm max. load Alternate optional configuration: - Isolated, loop-powered (user-supplied 24 Vdc loop power input), 700 ohm max. load	Default range is 4–20 mA dc. One current output standard. Maximum of two additional current outputs. Configure as loop-powered by removing a jumper.
Serial communications	RS232: 1 terminal block	Full duplex communication with remote terminal or PC.
Current input	4–20 mA DC current input	
Relays	Two relays optionally available on each I/O board Form C SPDT, isolated, 8 A, 220 Vac	Maximum of 6 relays. Process alarms can be assigned to control relays.
Display	4-line, backlit LCD	English language setup menus.

Output Signals

You can assign measurements to the 4–20 mA current output or have the measurement values sent to a remote terminal or host computer as serial data. One current output is provided on the standard I/O board, and two additional current outputs are available (one per I/O board).

Two optional relay outputs can be provided on each I/O board.

Note If the detector will be connected directly to customer equipment (i.e. the SGD-O transmitter will not be used), the detector output is 0 to 10 Vdc. ▲

Required Documentation

In addition to this guide, the following documents must be read and understood by all persons installing, using, or maintaining this equipment:

- SGD-O Installation Guide (p/n 717913)
- Gamma Radiation Safety Guide (p/n 717904)

Chapter 2
Getting Started

Powering the Transmitter

There are three input power options for the SGD-O transmitter:

- 12 Vdc version (standard)
- 24 Vdc (optional)
- 115/230 Vac (optional)

The transmitter power cable is configured to operate the 12 Vdc version only. In order to use the power cord for 24 Vdc or 115/230 Vac, modification to the power cord is required. This procedure is described in the SGD-O installation guide.

Caution Before setting up or calibrating the gauge, verify that proper input voltage is being supplied to the transmitter. Also verify the power cord is configured properly for the required power input. ▲

Interface

The Direct Access Method

With the direct access method, users input codes for parameters that need to be changed or codes to issue commands to the transmitter. This method allows you to bypass the menu structure and directly access a specific menu item. In order to use the direct access method, you must know the direct access code (DAC or the keypad code) for the desired parameter or command. The parameter DACs have six digits, and the command DACs have one, two, or three digits. Appendix E provides a list of commonly used parameter and command DACs.

Note This manual provides instructions using the direct access method, as it is a more efficient way to access menu items. ▲

Changing or Viewing Parameters

This section will show you how to change a parameter using the direct access method. In this example, change the value of the time constant. The DAC for the time constant parameter is **007004**.

1. Press: **EXIT SETUP, 007004, down arrow**.

2. To leave the value as is, press **EXIT SETUP**, and the gauge will return to its normal display mode.

   To change the value, enter the new value, and press the **down arrow, EXIT SETUP.** The gauge will begin using the new value immediately and will return to normal display mode.

Issuing Commands

This section will show you how to issue commands using the direct access method. In this example, force the current output to 20 mA. The command code is **5**.

1. Press: **EXIT SETUP, 5, down arrow**.

2. The display shows two options. Press the **left arrow** to reject the command or the **right arrow** to execute it.

Chapter 3
Detector Setup & Pre-Calibration

Procedure

For best performance, the detector must be adjusted for maximum signal on empty pipe. To do this, the unit must be connected to the transmitter and power applied.

Note There must not be any other nuclear sources within 10 feet of the unit being set up and calibrated. ▲

1. If the radioactive source has a shutter assembly, verify that it is in the ON position (shutter is open). If it is a high-pressure unit, the source will not have a shutter, and you can skip this step.

2. Remove the lid of the detector housing. Set it aside, leaving the wiring from the lid to the detector connected.

3. Verify that the J1 connector is running parallel with the pipe that the gauge is mounted on. This will orient the reed switch for proper operation. Also verify that the hold down bolt is tightened properly.

4. Refer to Figure 3–1. Use a voltmeter to verify that the +15 Vdc (pin 4 of J1) and -15 Vdc (pin 1 of J1) (power ground – pin 5 of J1) are there and within ± 0.5 Vdc of specified voltage. If one or both of the voltages are incorrect or not there at all, either the transmitter to detector cable is bad or the transmitter is not outputting the ±15 Vdc properly.

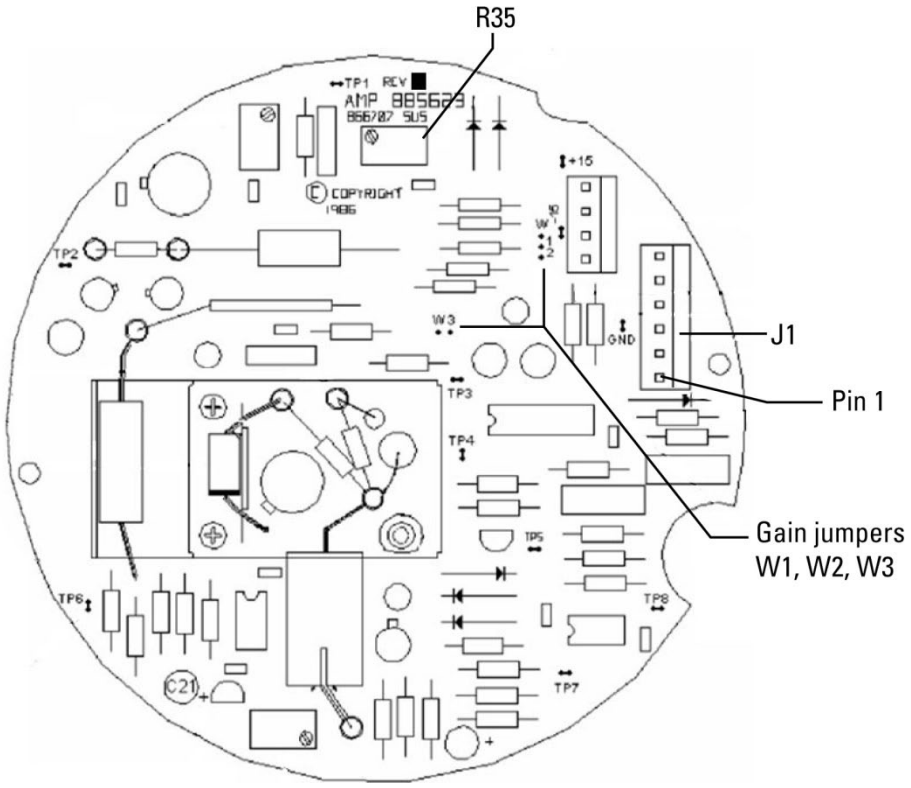

Figure 3–1.

5. Measure pins 2(-) and 3(+) for the Vdc output of the detector. Adjust R35 to obtain an output of 9.6 Vdc on empty pipe. If this voltage is achieved, attach the lid to the detector housing and skip to Chapter 4 to perform the calibration. Otherwise, continue to step 6.

6. If the output voltage stays at one value and using R35 does not change the output voltage, there is a high probability that the pre-amp board requires repair or replacement. Refer to the troubleshooting procedure in Chapter 9.

   If the output voltage will adjust with R35 but will not get up to the 9.6 Vdc required, check the gain jumpers (W1, W2, W3). Refer to Chapter 7 for a detailed discussion of gain adjustments. Once the gain jumpers are set and the 9.6 Vdc on empty pipe obtained, reattach the lid to the detector housing and continue to Chapter 4 to perform the calibration.

Note If the detector output is above 8.0 Vdc, the pipe ID is 6 inches or smaller, and the measurement range is under 10 PPA, it is acceptable to use the voltage and continue to the calibration procedure in Chapter 4. ▲

Chapter 4
Gauge Calibration

General

For optimum performance, calibrate the gauge exactly as described below. It is assumed that the gauge has been installed properly, the shutter is open (if applicable), the pipe is empty of any fluid, and that the SGD-O transmitter is being used.

Procedure

A condensed version of this procedure can be found in Appendix D. The appendix also provides space to record values.

Note Reference Chapter 2 for instructions on how to use a direct access code (DAC). ▲

1. Erase memory (DAC **74**). This step is necessary to ensure that all data is reset to factory defaults.

2. Load the standard oilfield setup into transmitter memory (DAC **1016**).

   After loading the setup, the top line of the display will be Measurement 1, which is lbs/Usg SolAdd. {This unit is equal to today's PPA (pounds of proppant added) per US gallon of carrier fluid. The measurement may have also been in PSA (pounds of sand added), which is pounds of proppant added per gallon of carrier fluid pumped.}

   The second line of the display will show the bulk density in lb/US Gal, and the third line will show the bulk density in g/ml.

3. Enter the pipe ID in inches (DAC **048003**). It is important this value be as accurate as possible.

Caution Once the pipe ID is entered, do not change it, even if the entry is incorrect. Changing the value after calibration is performed will invalidate the calibration. ▲

4. To determine the water/air ratio, first standardize the gauge with pipe full of air using (DAC **121**). When finished, fill the pipe full of water and allow the detector to stabilize for approximately five minutes.

5. Calibrate the gauge with pipe full of water (DAC **4**). This will result in the second half of the water/air ratio. When finished, leave the pipe full of water.

6. Recall the water/air ratio (DAC **118003**). The water/air ratio is used to obtain the calibration factor in the next step. Based on the setting of 9.6 Vdc on air and the pipe ID, the ratio should be close to the ones listed in the table below.

   Figure 4–1. Pipe IDs and water/air ratios

Pipe ID	Ratio	Pipe ID	Ratio
2″	0.75	6″	0.375
3″	0.625	8″	0.25
4″	0.5	10″	0.125

   Note If the ratio is not near the one shown for your pipe ID, then an error occurred. Stop the calibration process and start again. ▲

7. Refer to Appendix C. There are four calibration tables grouped by pipe ID. Using the pipe ID and the water/air ratio, locate the factor and record it. The calibration factor is used to calculate the ZnCl (zinc chloride) value used to obtain the slope correction for a 2-point calibration curve.

   Note If your ratio is between 0.98 and 1.00, there was either air or water in the pipe for both the standardization and calibration cycles. If this is the case, stop the calibration process and start again. ▲

8. Clear the "Cal Point Pending" message (DAC **49**). When you return to the main screen, the alarm will still be displayed. Press the EXIT SETUP key twice to clear the alarm.

9. Reset the CAL/REF ratio to the default value of 1.000 (DAC **086003**).

10. Standardize the gauge on water (DAC **121**). This will set the standardization value (water value) that will be used to calculate the ZnCl calibration value.

11. When standardization is complete, recall the water signal value (DAC **128003**). Record this value.

    Note The water signal value will be displayed with *E4* at the end of it. The calculation in the next step will be easier using a whole number. To record this value as a whole number, move the decimal to the right four places. For example, 3.123E4 is 31230. ▲

12. Calculate the ZnCl signal:

    $$\text{ZnCl Value} = \text{Water Signal from step 11} \times \text{Factor from step 7}$$

    For example, if the factor obtained in step 7 is 0.5077 and the water signal value from step 11 is 31230, then:

    $$\text{ZnCl Value} = 31230 \times 0.5077 = 15855$$

13. Enter the calculated ZnCl value calculated in step 12 into memory (DAC **133003**).

    Note Values in scientific notation (values greater than 99999) must be entered differently. Enter the base first. Then press the decimal key to bring up the E, which indicates the start of the exponent. Enter the exponent. ▲

14. Hold the output at the ZnCl signal value (DAC **137**). The displayed values will change.

15. Observe the process g/ml value on the third line of the display. It should be near 1.812 g/ml. If it is below 1.6 or above 2.0 g/ml, it is likely that an error occurred. Repeat this procedure.

16. Recall the density slope correction factor (DAC **049003**). Record this value.

17. Recall the carrier specific gravity (DAC **085003**). Record this value.

    Note The values recorded in steps 16 and 17 are required for troubleshooting purposes. Keep these values handy. ▲

18. With the ZnCl hold active, check the third line of the display. **Exactly 1.812 g/ml should be displayed.**

    Adjust the density slope correction factor if necessary (DAC **049003**). Return to the main screen. The display will update in approximately three seconds. If the displayed value is not 1.812 g/ml, observe how far off the value is. Make another adjustment to the slope correction factor (DAC **049003**). Return to the main screen and wait for the screen to update. Repeat this process until the third line of the display is exactly 1.812 g/ml.

19. Clear the ZnCl hold (DAC **9**). This will return the gauge to normal operation.

20. The displayed density should then be 1.000 g/ml.

The gauge is now calibrated for use of water as the carrier.

Note This calibration will be valid as long as the detector is not moved or removed from the housing. ▲

Chapter 5
Post Calibration - Setup at the Job Site

General

This procedure assumes that you have completed the pre-calibration procedures in Chapter 3 and the calibration procedures in Chapter 4.

Procedure

Once the SGD-O gauge is in service, one more operation is necessary for proper indication of the Pounds of Sand Added and the Pounds per Gallon indications of the gauge.

Note Reference Chapter 2 for instructions on how to use a DAC. ▲

1. Allow carrier fluid into the pipe that the gauge is mounted on. Let the indication stabilize, and record the density value (g/ml) shown on the third line of the gauge display.

2. Recall the carrier specific gravity (DAC **085003**). Record the value that is displayed. (This is the value used during calibration, and you will need to re-enter this value when the current pumping job is finished.) Enter the value recorded in step 1. Press the **down arrow** and then **EXIT SETUP**.

3. View the detector signal (DAC **112003**). Observe the value for several seconds to obtain an average and record it. Press **EXIT SETUP** twice and enter **128003**.

   Enter the value you just recorded (from 112003). To enter a value in scientific notation, enter the base first. Then press the decimal key to bring up the E, which indicates the start of the exponent, and then enter the exponent.

   Note that this step can also be done by performing a standardization on the fluid at this point in the procedure (DAC **121**).

Your gauge is now fully calibrated and ready to use. Both the Pounds of Sand Added and the Pounds per Gallon indications will be correct.

When the job is finished, return the carrier density to its original value (DAC **085003**). To prepare for the next job, perform a standardization on a pipe full of clean water (DAC **121**).

Chapter 6
The Current Output

Hold the Current Output

The standard 4–20 mA output can be adjusted so the control room and local display readings are identical. In order to do this and to check the connection, hold commands will be used to set the current output to known value.

Note Reference Chapter 2 for instructions on how to use a DAC. ▲

1. Hold the current output at 4 mA (DAC **8**).

   If the value is not 4 mA after executing this command, you can apply a correction factor. First, determine the correction factor by dividing the new value by the initial value. For example, if the current output is 3.98 mA, divide 4.0 by 3.98:

   4.0/3.98 = 1.005.

   In this case, the correction factor is 1.005. Enter the correction factor (DAC **053013**).

Note The initial value in this formula is the measured value of the 4 mA output when the correction factor is equal to 1.0. ▲

2. Hold the current output at 20 mA (DAC **5**).

   If the value is not 20 mA after executing this command, you can apply a correction factor. First, determine the correction factor by dividing the new value by the initial value. For example, if the current output is 20.04 mA, divide 20.0 by 20.04:

   20.0/20.04 = 0.998.

   In this case, the correction factor is 0.998. Enter the correction factor (DAC **052013**).

Note The initial value in this formula is the measured value of the 20 mA output when the correction factor is equal to 1.0. ▲

3. Hold the current output at 12 mA (DAC **2**).

Clear All Holds

Use the Clear All Holds command (DAC **9**) to return the current output to its normal operation.

Check the Input Signal

The output of the detector (input to the transmitter) is a voltage signal 0–10 Vdc maximum. Read the signal (DAC **112003**). The value is displayed in scientific notation and represents a range of 0 to 10 volts with the numbers 0 to 6.554E4 (65540).

Chapter 7
Adjusting the Gain Settings

Overview

Users of the SGD-O density gauge often move the detector assembly from application to application. Among these different applications are variations in sizes and schedules of pipes, as well as activity and ages of radioactive sources. The gauge's hardware gain settings are set for a particular application; thus, it may be necessary to change certain jumpers or components to set the detector within its allowable voltage range for the current application.

This chapter explains how to set the gain values for the Fast Start Unit (FSU) pre-amp board so that it can be used in different applications without having to return it to the factory for modification.

Note This chapter applies to the SGD-O FSU pre-amp board 885623 at revision F or later. ▲

Note Before proceeding, verify that the R1 and R28 factory adjustments have not been altered. If those adjustments are not set correctly, the gain circuit will not function correctly. Reference the FSU troubleshooting procedure in Chapter 9. ▲

Components and Jumpers

Warning Ensure that power is off and the area is non-hazardous before making any of the adjustments described in this document. ▲

The R35 potentiometer (pot) is a fine tuning pot only. It was never intended to be a full-scale adjustment. Therefore, if you cannot get the detector output up to 9.6 Vdc by adjusting the R35 pot, with air in the pipe, the hardware gain will have to be modified. A number of components and jumpers on the pre-amp board can be adjusted in such instances. Specifically, these are components C13, R5, R36, R37 and wire jumpers W1, W2, and W3. See Figure 7–1.

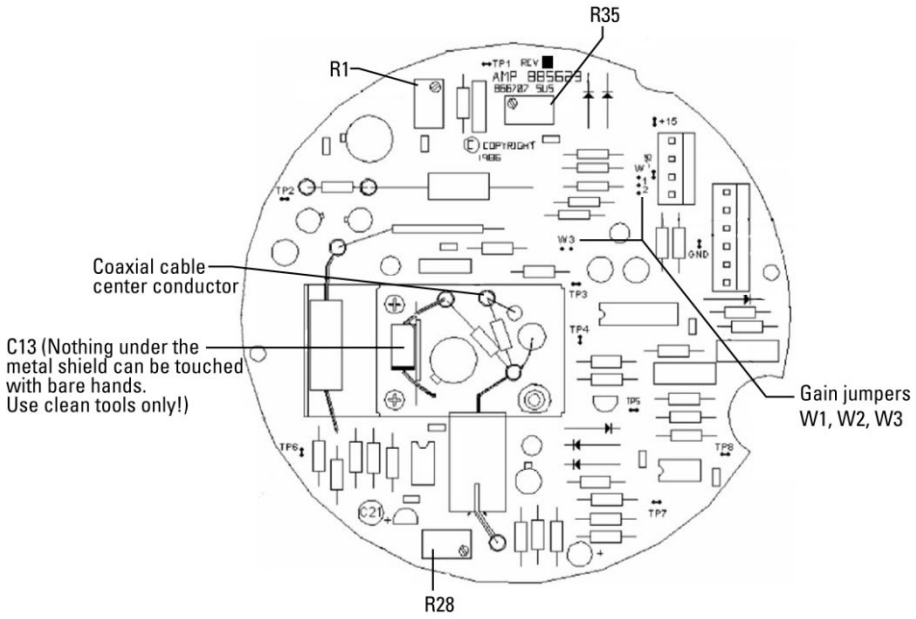

Figure 7–1. FSU pre-amp board components and gain jumpers

Caution The C13 capacitor is located under the metal shield on the FSU pre-amp board. **Everything under this shield is high impedance circuitry. Do not touch anything under the shield with bare hands!** If any of these components are contaminated, the detector signal will fluctuate, making the detector ineffective. **Use only clean metal tools to touch these components. Do not apply any kind of cleaner to them. ▲**

For most applications, the value of the C13 capacitor is normally 330 pF. However, as shown in Table 7–1, the value of C13 can also be 220 pF or 470 pF, depending on the application for which the detector was originally purchased. A 220 pF capacitor will make the gain higher and a 470 pF capacitor will make the gain lower. If you are having trouble getting the gain either high enough or low enough, check the value of C13.

Table 7–1. FSU setup to obtain required voltage reading

Pipe Size	Source Size	C13 (Default 330 pF)	Gain Setting (Default 1X)
2″ HP	100 mCi	330 or 470 pF	1X or 2X
2″ HP	145 mCi	330 or 470 pF	1X
2″ HP	200 mCi	330, 470, or 680 pF	1X
3″ HP	200 mCi	330 pF	1X
4″ HP LP	200 mCi	330 or 470 pF	1X or 2X
6″ LP	200 mCi	330 or 470 pF	2X
8″ LP	200 mCi	220 or 330 pF	2X
10″ LP	200 mCi	220, 330, or 470 pF	2X or 3X

Gain Control Settings

Figure 7–2 shows how the jumpers and resistors work together to control the gain of the AR1 op-amp.

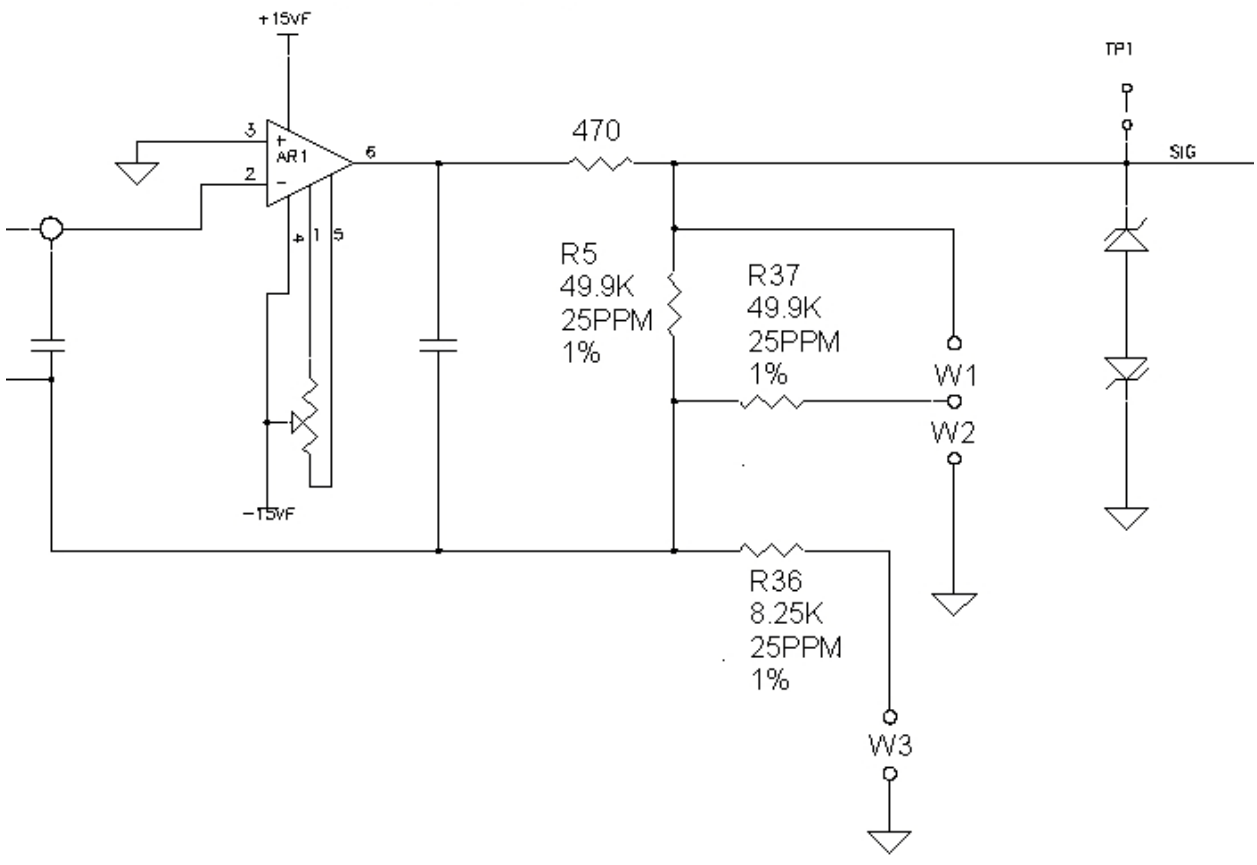

Figure 7–2. Gain control of the AR1 op-amp

The gain settings listed in Table 7–2 are based on the following component values being installed on the FSU pre-amp board.

- R5 = 49.9 kohm, 1% precision
- R36 = 8.25 kohm, 1% precision
- R37 = 49.9 kohm, 1% precision
- C13 = 330 pF

Note On the three solder points of the W1/W2 jumper points, the center point is the common. Therefore, the wire jumper goes from the center point up to the 1 point for the W1 jumper or from the center point down to the 2 point for the W2 jumper. ▲

Install the proper gain components until the R35 pot will adjust the voltage output of the detector, with air in the pipe, to 9.6 Vdc. As an example, the R35 pot should adjust the voltage out from 10 Vdc to approximately 8.0 Vdc. If the R35 pot will only adjust the detector output from 4.0 to 5.0 Vdc, you will need to double the gain.

If you are already on the lowest gain and the voltage will not go down, the factory pot settings may have been changed. Verify the R1 and R28 factory settings.

Changing C13 will move the entire gain curve either up or down depending on the capacitor used. Figure 7–3 shows the relationship C13 has in the control circuit of the FSU detector.

Table 7–2. Gain settings

Times	Setting	Comment
Unity gain (no gain)	No jumpers	This may be necessary on 3" or 4" pipes with newer sources to prevent saturating the detector.
X1	W1 jumper	This is the normal setting and adds a preset amount of gain to the circuit over the unity gain (no jumper) setting.
X1.5	W1 jumper + W3 jumper + R36 changed to 49.9 kohm	The W1 jumper puts R5, R37 in parallel with W3 installed. Changing R36 changes the current of the feedback loop to the op-amp.
X2	W2 jumper	This leaves the W5 leg at 49.9K but puts R37 into the feedback loop, changing the current to the op-amp.
X3	W2 jumper + W3 jumper + R36 changed to 49.9 kohm	This leaves the W5 leg at 49.9K and puts R36 and R37 in parallel, changing the current to the op-amp.

Times	Setting	Comment
X4	W1 jumper + W3 jumper	This parallels R5 and R37 and adds R36 to the circuit, changing the current to the op-amp.
X5	W2 jumper + 8.25 kohm resistor used as W3 jumper, instead of the wire	Using the resistor instead of the wire provides more versatility to adjusting the current in the feedback loop to the op-amp.
X6	W2 jumper + 8.25 kohm resistor used as W3 jumper + R36 changed to 4.12 kohm	Using the resistor instead of the wire provides more versatility to adjusting the current in the feedback loop to the op-amp. An 8.25 kohm resistor soldered parallel onto R36 will change R36 to 4.12 kohm.
X7	W3	Everything else remains at default values.
X8	W2 jumper + W3 jumper	Everything else remains at default values.

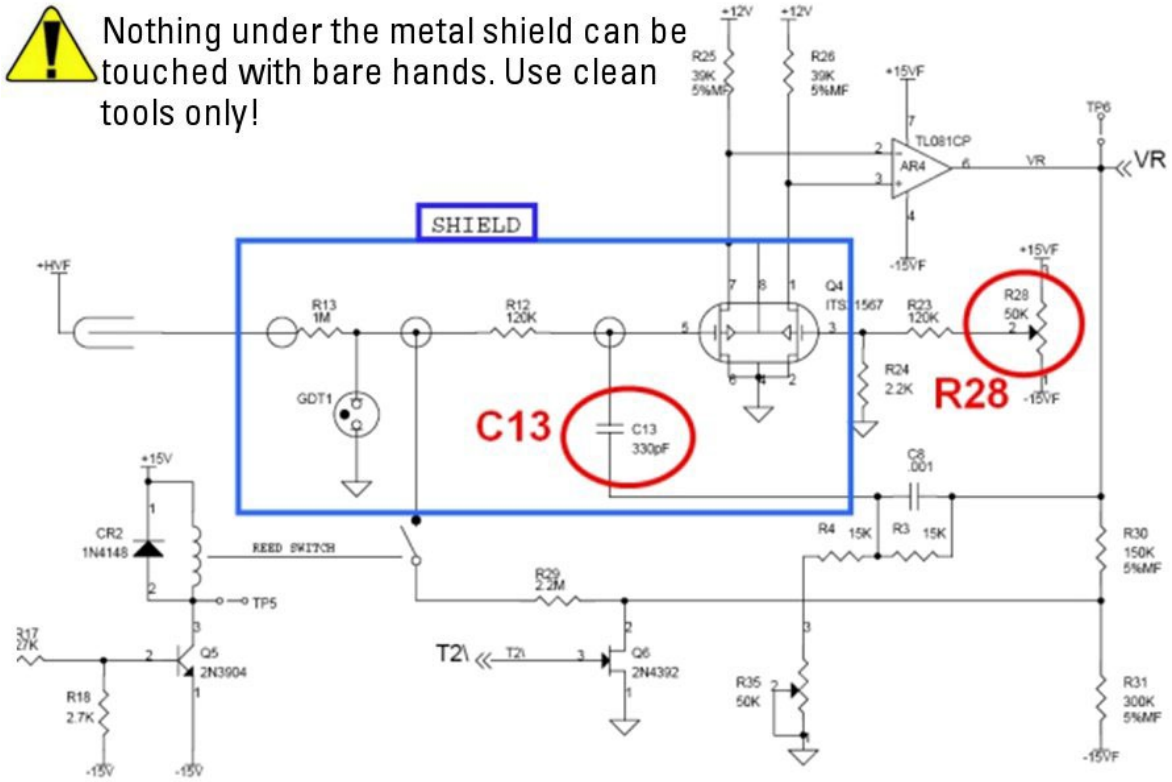

Figure 7–3. C13 in the control circuit of the FSU detector

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Chapter 8
Maintenance

Overview

The SGD-O is fairly maintenance free, but you should follow the schedule below to remain in compliance. The tasks are described in further detail in the sections that follow.

Table 8–1. Maintenance schedule

Task	Interval
Complete a shutter check (if the system has a shutter).	Every 6 months.
Complete a tag check.	Every 6 months.
Complete a source housing check.	Every 6 months.
Complete a leak test.	Every 36 months for U.S. or every 12 months for Canadian installations.

Shutter Check

If your system has a shutter, complete a shutter check every six months. The shutter check consists of the following two steps.

1. Slide the shutter to each position to make sure it functions properly.

2. Visually inspect the shutter, ensuring it has not been damaged and that all of the lead plates are in place.

Tag & Label Check

Complete a tag and label check every six months. All labels and tags attached to the source must be visible per radiation safety standards. All labels and tags must be securely attached and legible (including engraved labeling). Immediately replace any label that is damaged, illegible, or not securely attached.

Do NOT paint or overcoat the source housing without first masking the radiation identification tag and other labeling.

Below are examples of the tags and labels that may be a part of your system.

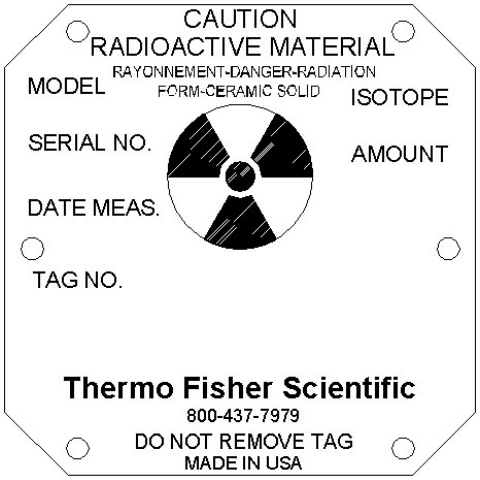

Figure 8–1. Source identification tag example

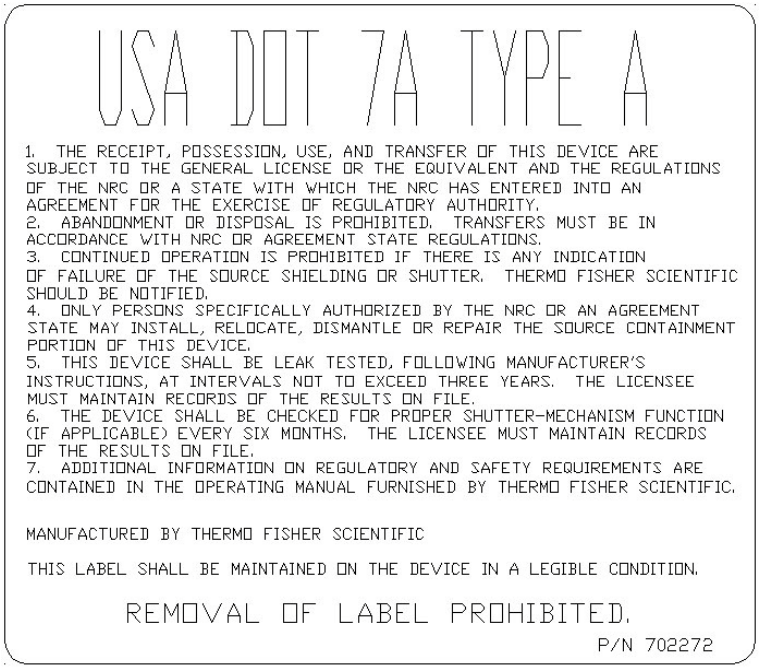
USA DOT 7A TYPE A
1. THE RECEIPT, POSSESSION, USE, AND TRANSFER OF THIS DEVICE ARE SUBJECT TO THE GENERAL LICENSE OR THE EQUIVALENT AND THE REGULATIONS OF THE NRC OR A STATE WITH WHICH THE NRC HAS ENTERED INTO AN AGREEMENT FOR THE EXERCISE OF REGULATORY AUTHORITY.
2. ABANDONMENT OR DISPOSAL IS PROHIBITED. TRANSFERS MUST BE IN ACCORDANCE WITH NRC OR AGREEMENT STATE REGULATIONS.
3. CONTINUED OPERATION IS PROHIBITED IF THERE IS ANY INDICATION OF FAILURE OF THE SOURCE SHIELDING OR SHUTTER. THERMO FISHER SCIENTIFIC SHOULD BE NOTIFIED.
4. ONLY PERSONS SPECIFICALLY AUTHORIZED BY THE NRC OR AN AGREEMENT STATE MAY INSTALL, RELOCATE, DISMANTLE OR REPAIR THE SOURCE CONTAINMENT PORTION OF THIS DEVICE.
5. THIS DEVICE SHALL BE LEAK TESTED, FOLLOWING MANUFACTURER'S INSTRUCTIONS, AT INTERVALS NOT TO EXCEED THREE YEARS. THE LICENSEE MUST MAINTAIN RECORDS OF THE RESULTS ON FILE.
6. THE DEVICE SHALL BE CHECKED FOR PROPER SHUTTER-MECHANISM FUNCTION (IF APPLICABLE) EVERY SIX MONTHS. THE LICENSEE MUST MAINTAIN RECORDS OF THE RESULTS ON FILE.
7. ADDITIONAL INFORMATION ON REGULATORY AND SAFETY REQUIREMENTS ARE CONTAINED IN THE OPERATING MANUAL FURNISHED BY THERMO FISHER SCIENTIFIC.
MANUFACTURED BY THERMO FISHER SCIENTIFIC
THIS LABEL SHALL BE MAINTAINED ON THE DEVICE IN A LEGIBLE CONDITION.
REMOVAL OF LABEL PROHIBITED.
P/N 702272

Figure 8–2. DOT 7A Type A label with General License information

The DOT 7A Type A label example above (p/n 702272) provides General License information and is only used on instruments going to customers with a General License.

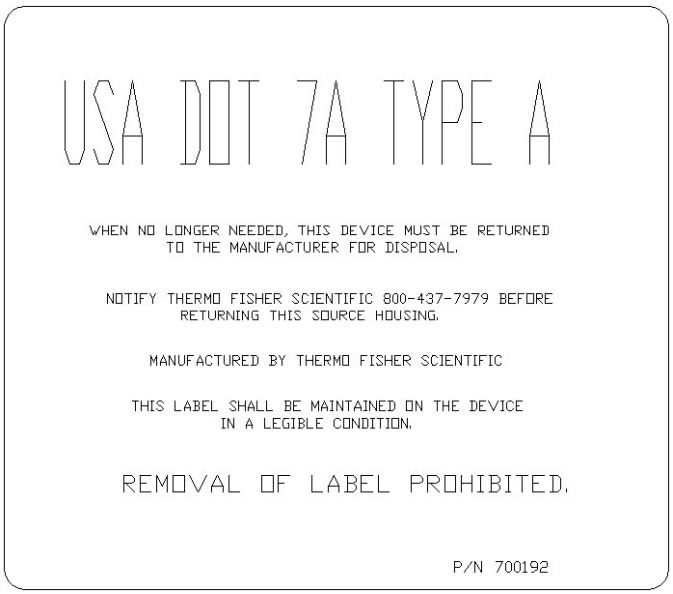
USA DOT 7A TYPE A
WHEN NO LONGER NEEDED, THIS DEVICE MUST BE RETURNED TO THE MANUFACTURER FOR DISPOSAL.
NOTIFY THERMO FISHER SCIENTIFIC 800-437-7979 BEFORE RETURNING THIS SOURCE HOUSING.
MANUFACTURED BY THERMO FISHER SCIENTIFIC
THIS LABEL SHALL BE MAINTAINED ON THE DEVICE IN A LEGIBLE CONDITION.
REMOVAL OF LABEL PROHIBITED.
P/N 700192

Figure 8–3. DOT 7A Type A label example with Specific License information

The DOT 7A Type A label example above (p/n 700192) provides Specific License information and is only used on instruments going to customers with a Specific License.

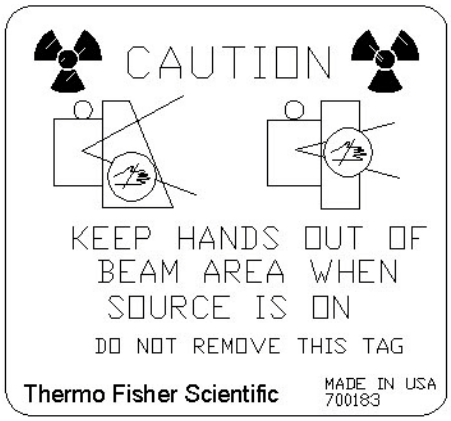

Figure 8–4. Caution tag example

Note None of these tags should be removed, painted over, or remain illegible. ▲

Source Housing Check

Complete a source housing check every six months. This check consists of looking for rust, corrosion, worn parts, damaged housing, missing tags, illegible tags, and a worn or broken shutter (if your system has a shutter).

Warning Use a long handled brush to remove debris in the beam path to ensure that no part of your body, including your hands, enters the radiation beam path. ▲

Leak Tests

Leak testing is a regulatory requirement. It must be completed every 36 months in the United States or every 12 months in Canada.

Thermo Fisher is licensed to perform these tests and can do so through contract services. If you are currently using the leak testing service provided by Thermo Fisher or purchased the gauge after July 1, 2006, you will be mailed a notification letter 60 days prior to the due date of your leak test. Two weeks later you will receive your leak test kit in the mail. If you wish to participate in this service, follow the instructions in the kit, and return it to Thermo Fisher.

If you purchased a gauge prior to the above date, you can request to be added to Thermo Fisher's leak test service.

Chapter 9
Troubleshooting & Service

Recovering Memory

If the memory or instrument calibration has been lost but the detector and electronics are still functional, follow the procedure below to recover memory.

Note This procedure assumes that the SGD-O gauge was fully calibrated as described in this manual and that the water standardization value and slope correction value were recorded from the last calibration. If these two values are not available, it is not possible to perform this procedure. ▲

Note Reference Chapter 2 for instructions on how to use a DAC. ▲

1. Erase memory (DAC **74).**
2. Load the oilfield setup (DAC **1016**).
3. Enter the pipe ID (DAC **048003**).
4. Run the standardization cycle (DAC **121**). (Ignore what is in the pipe. This was done to set command flags in memory.)
5. Enter the water value recorded during the last calibration (DAC **128003**).
6. Enter the slope correction value recorded from the last calibration (DAC **049003**).

The gauge will now be in the condition it was when brought to the job site. Any changes made to the instrument at the job site should be done now.

The Transmitter

This section provides troubleshooting procedures for the SGD-O transmitter.

The Display

The instrument sends continuous readouts to the display. If the display is blank, the readout is dim, or the readout displays in a yellow-green color, increase the contrast by pressing the up arrow on the transmitter keypad.

If the display consists of dark rectangles, decrease the contrast by pressing the down arrow.

If adjusting the contrast does not correct the display problem, first verify the power supply at the source. If this is not the problem, remove power from the transmitter. Open the enclosure and verify that the keypad cable is properly installed on the CPU board.

If transmitter still does not display, the CPU board may be malfunctioning. Refer to the SGD-O installation manual for instructions on replacing boards in the transmitter.

The DC Power Fuse

If you suspect a problem with the DC power fuse, power down the unit and measure the resistance with a multimeter. If the fuse is good, the reading will be approximately 0 ohms.

You can also look at the fuse and determine it is bad if it looks brown.

Note See Figure 9–1. If you are using a 12 Vdc board, the fuse is at F2. ▲

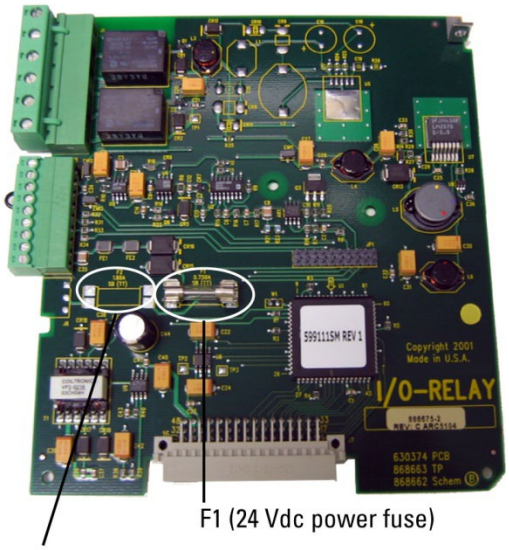

Figure 9–1. DC power fuses on the I/O relay board

The Detector

This section provides a procedure for general troubleshooting of the detector. If you suspect a problem with the pre-amp board specifically, also follow the procedure in the next section, "The FSU Pre-Amp Board."

The locations of the components and jumpers referenced in this procedure are shown in the figures below.

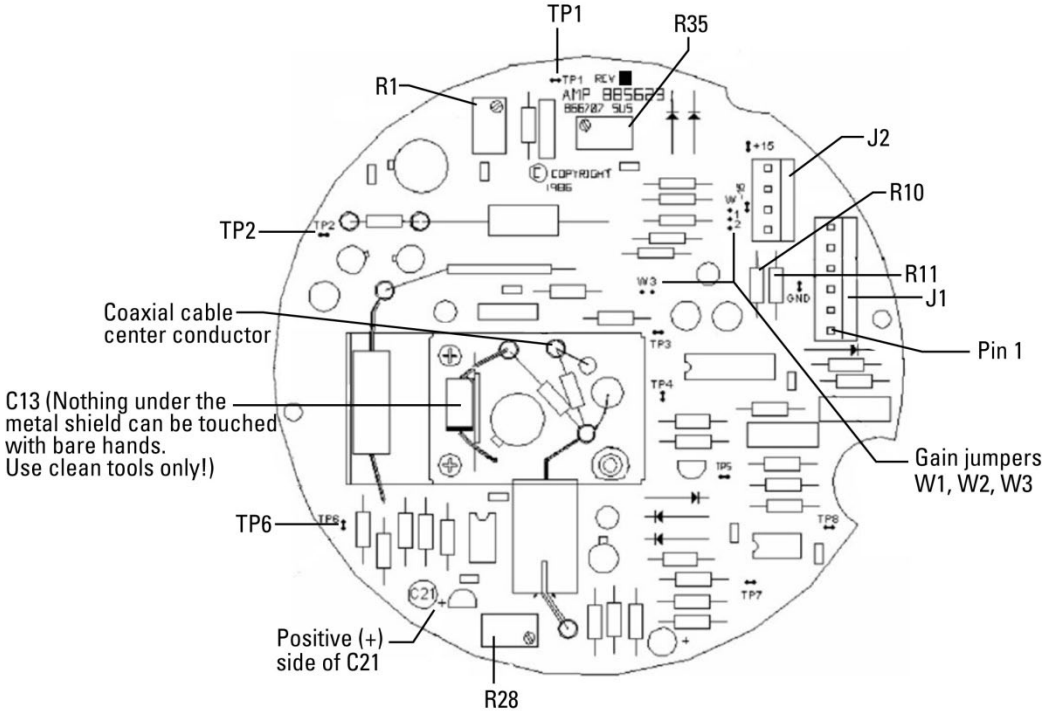

Figure 9–2. SGD-O FSU pre-amp board

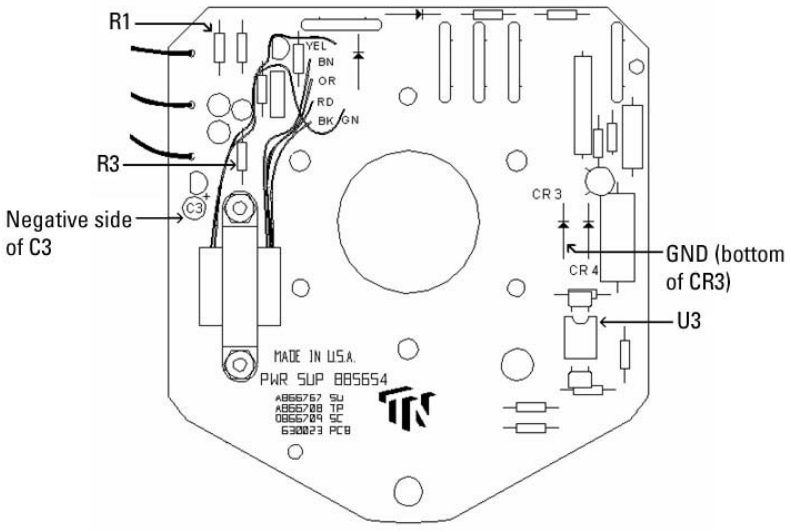

Figure 9–3. Power supply board

1. Check the detector signal by entering DAC 112003 at the transmitter. If the detector is set to 9.6 Vdc on air, the value should be approximately 6.311E4.

   If the value shown is 6.542E4, the detector signal is over 10 Vdc and the detector will not work. If the value shown is less than 6.200E4, then the detector gain is not set correctly or the detector is malfunctioning. Refer to Chapter 7 to adjust the gain settings.

2. Remove the detector lid. Use a voltmeter to measure the voltage from pin 1 to pin 4 of J1 on the pre-amp board. Pin 1 is the pin furthest from the edge of the board. The reading should be approximately 30 Vdc. If it is, both the +15 Vdc and -15 Vdc are coming from the transmitter and reaching the detector.

   If the voltage is only 15 Vdc, then one of the 15 Vdc supplies is not reaching the detector. If the voltage is zero, then neither 15 Vdc supplies are reaching the detector. Check cabling and the output of the transmitter VPI board.

3. Measure pin 2 to pin 3 of J1. This is the output of the detector. It should be 9.6 Vdc with air in the pipe.

   If the output is 9.6 Vdc ±3.0 volts, use the R35 potentiometer on the pre-amp board to adjust the output to 9.6 Vdc with air in the pipe.

   If the output is above 10 Vdc and will not adjust, verify the gain jumper is on W1 and the W3 jumper is not installed. If necessary, modify these jumpers.

   With the gain jumper on W1 and W3 not installed, fill the pipe with water and see if the voltage drops below 10 Vdc. If it does not, the pre-amp board requires repair or replacement.

4. If the output voltage does drop below 10 Vdc when the pipe is filled with water, then the gain is set too high. Remove the W1 jumper completely and the gain will lower to the point that you should be able to use R35 to adjust the output to 9.6 Vdc on a pipe full of air.

   If the output voltage can be adjusted with the R35 pot, but will not increase to the 9.6 Vdc, on a pipe full of air, then the gain is set too low. Move the W1 jumper to W2 (keeping in mind that the center hole is the common connection). In most cases, you should now be able to use the R35 pot to adjust the output to 9.6 Vdc on air.

If the output voltage is very low and using the R35 pot will only adjust the output approximately 0.5 to 1.0 Vdc, check the R5 resistor on the pre-amp board. If it is a 49.9 kohm resistor, replace it with an 8 kohm resistor. Doing this should raise the gain enough to obtain the 9.6 Vdc output with air in the pipe. If it does not, it is like the pre-amp requires repair or replacement.

5. If you suspect the pre-amp board is bad, check the factory settings on the board. Continue to the next section.

Note If you purchased a pre-amp board (p/n 885623) by itself as a spare part, the R1 and R28 pots have not been set. In this case, it is necessary to follow the procedure in the next section so the pre-amp board will operate properly. ▲

6. With power applied to the pre-amp board, connect a wire jumper from the center conductor coaxial cable to test point 6. Measure the voltage at test point 6 and use the R28 pot to set this voltage to -80 mV. Measure the Vdc on test point 1 and use the R1 pot to set this voltage to +5 mV.

The FSU Pre-Amp Board

This section provides a procedure for troubleshooting the SGD-O FSU pre-amp board (p/n 885623). The procedure will aid technical personnel in determining if suspected problems with the pre-amp board are simple calibration issues that can be resolved with adjustment of the potentiometers on the board or actual component failures that require the board be replaced or returned to the factory for repair.

Two Hi-Meg resistors are required. They are listed below with the Thermo Fisher Scientific part numbers.

- 4.7 x 109 ohm resistor, p/n 351760
- 4.7 x 1010 ohm resistor, p/n 351810

Note If you purchased a pre-amp board (p/n 885623) by itself as a spare part, the R1 and R28 pots have not been set. In this case, it is necessary to follow this procedure so the pre-amp board will operate properly. ▲

The locations of the components and jumpers referenced in this procedure are shown in Figure 9–2 and Figure 9–3.

Caution The C13 capacitor is located under the metal shield on the FSU pre-amp board. **Everything under this shield is high impedance circuitry. Do not touch anything under the shield with bare hands!** If any of these components are contaminated, the detector signal will fluctuate, making the detector ineffective. **Use only clean metal tools to touch these components. Do not apply any kind of cleaner to them.** ▲

1. Check the FSU detector power supply voltages.

   There are + 15 and - 15 volt supplies on the pre-amp board coming from the power supply in the panel. Test points are provided for both supplies near J2. The ground test point is near J1. R10 and R11 on the pre-amp are 10-ohm resistors that are in series with the -15 and +15 volt supplies.

   The voltage drops across these two resistors are listed below. There is also a +12 volt regulator on the pre-amp board. This voltage can be checked on the positive side of C21.

   Measure + 15V and - 15V supply current tap voltages:

   +15V: Voltage drop across R11 should be between 80 mV and 220 mV.

   -15V: Voltage drop across R10 should be between 40 mV and 150 mV.

   Measure +12V at positive (+) side of C21:

   +12V voltage: Should be between 11.0 V and 13.0 V.

2. Check the high voltage on the power supply board. It should be between 1300 Vdc and 1600 Vdc. This voltage can be measured on the ion chamber.

   There are +15 and - 15 volt supplies on the high voltage power supply board coming from the power supply in the panel. R1 and R3 on the high voltage power supply board are 10-ohm resistors that are in series with the -15 and +15 volt supplies.

   The voltage drops across these two resistors are listed below. There is a -12 volt regulator on the power supply board. This voltage can be checked on the negative side of C3. The ground point is on the bottom end of CR3 nearest U3.

   Measure +15V and -15V supply current tap voltages:

   +15V current: Voltage drop across R1 should be between 130 mV and 280 mV.

   -15V current: Voltage drop across R3 should be between 130 mV and 280 mV.

Measure -12V supply voltage (negative lead to ground) at negative (-) end of C3:

-12V voltage: Should be between -11.0 V and -13.0 V.

Check the high voltage drive on U3B. Measure U3, pin 7:

U3 voltage, pin 7: Should be between 0.0 V and 7.0 V.

3. Verify the pre-amp has been zeroed. To do this, connect a jumper from the center conductor of the coaxial cable to test point 6, and measure the voltage at test point 6. Using R28, set this voltage to -80 mV. Measure the voltage on test point 1. Using R1, set this voltage to +5 mV.

4. Remove the jumper and verify that test point 1 stays near zero with no radiation on the detector. Test point 6 will ramp down from approximately +7 volts to -10 volts and reset. The speed of the ramp is proportional to the amount of radiation on the detector. With no radiation, this voltage moves very slowly.

   If no radiation is available, you can inject a current into the pre-amp using a large resistor in series with the +15 volt supply.

   - For boards that have the gain chip U2 (LF13006N), install jumpers W3 and W4.
   - For boards without the gain chip, install jumper W1.

Reset Pulse Width Tests

Connect a 4.7 x 10^9 ohm resistor from the +15 volt supply to the pre-amp input terminal.

Measure reset pulse widths with an oscilloscope:

T1 (at TP4): Should be between 25 ms and 65 ms.

T2 (at TP3): Should be between (T1+14 ms) and (T1+37 ms).

T3 (at TP2): Should be between (T1+14 ms) and (T1+37 ms) (this is a negative pulse).

Remove the 4.7 x 10^9 ohm resistor.

Gain Test

Allow 24 seconds on this measurement.

Connect a 4.7×10^{10} ohm resistor from the +15 volt supply to the pre-amp input terminal.

Measure TP1 voltage. It should be between 3.9 V and 4.6 V, with optimum measurement at 4.2 V.

The absolute voltage is not as important as the stability of the voltage. Variance after stabilization must be less than 10 mV.

Remove the 4.7×10^{10} ohm resistor.

Disassembly

Disassembly of the instrument is not allowed.

The only exception to this statement is for those with a Specific License that contains special permission to separate the source housing from the pipe.

Persons with a General License are never allowed to disassemble the source housing from the pipe.

Additionally, the Type A shipping certificate is issued to the instrument as a single component consisting of the detector, source housing, and pipe. If the source housing is separated from the pipe, it is no longer covered by the Type A shipping certificate.

Contact Information

The local representative is your first contact for support and is well equipped to answer questions and provide application assistance. You can also contact Thermo Fisher directly.

Process Instruments		
1410 Gillingham Lane Sugar Land, TX 77478 USA +1 (800) 437-7979 +1 (713) 272-0404 direct +1 (713) 4573 fax	14 Gormley Industrial Avenue Gormley, Ontario L0H 1G0 CANADA +1 (905) 888-8808 +1 (905) 888-8828 fax	Unit 702-715, 7/F Tower West Yonghe Plaza No. 28 Andingmen East Street, Beijing 100007 CHINA +86 (10) 8419-3588 +86 (10) 8419-3580 fax
A-101, 1CC Trade Tower Senapati Bapat Road Pune 411 016 Maharashtra, INDIA +91 (20) 6626 7000 +91 (20) 6626 7001 fax	Ion Path, Road Three Winsford, Cheshire CW7 3GA UNITED KINGDOM +44 (0) 1606 548700 +44 (0) 1606 548711 fax	
www.thermoscientific.com		

Warranty

Thermo Scientific products are warranted to be free from defects in material and workmanship at the time of shipment and for one year thereafter. Any claimed defects in Thermo Scientific products must be reported within the warranty period. Thermo Fisher shall have the right to inspect such products at Buyer's plant or to require Buyer to return such products to Thermo Fisher plant.

In the event Thermo Fisher requests return of its products, Buyer shall ship with transportation charges paid by the Buyer to Thermo Fisher plant. Shipment of repaired or replacement goods from Thermo Fisher plant shall be F.O.B. Thermo Fisher plant. A quotation of proposed work will be sent to the customer. Thermo Fisher shall be liable only to replace or repair, at its option, free of charge, products which are found by Thermo Fisher to be defective in material or workmanship, and which are reported to Thermo Fisher within the warranty period as provided above. This right to replacement shall be Buyer's exclusive remedy against Thermo Fisher.

Thermo Fisher shall not be liable for labor charges or other losses or damages of any kind or description, including but not limited to, incidental, special or consequential damages caused by defective products. This warranty shall be void if recommendations provided by Thermo Fisher or its Sales Representatives are not followed concerning methods of operation, usage and storage or exposure to harsh conditions.

Materials and/or products furnished to Thermo Fisher by other suppliers shall carry no warranty except such suppliers' warranties as to materials and workmanship. Thermo Fisher disclaims all warranties, expressed or implied, with respect to such products.

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Appendix A
Ordering Information

Table A–1. SGD-O Transmitter

P/N	Description
490128	Transmitter mounting kit
817653	Transmitter power cable
886420-1	Display board
886724	CPU board, without EPROM
886765	CPU board, with EPROM
886675-1	I/O board, 24 Vdc input
886675-3	I/O board, 12 Vdc input
886675-5	I/O board, no DC input
CP6879901	VPI board, modified for SGD-O

Table A–2. Ion Chamber Detector

P/N	Description
050273	Complete ion chamber detector, with boards
050274	Electronics board set
885623	Pre-amp board
885654	HV power supply

Table A–3. Lids & Lid Cables

P/N	Description
886161	Lid, BJ Services
810111	Cable, BJ Services lid
885971	Lid, Jupiter
810112	Cable, Jupiter lid
885748	Lid, MS Conn
818100	Cable, MS Conn

Table A–4. Detector-Transmitter Cables

P/N	Description
810121	20-ft. cable
810122	30-ft. cable
817603	100-ft. cable
817604	150-ft. cable

Table A–5. Spares

P/N	Description
050268	Housing with detector, no lid
45373B	Plastic spacer (ion chamber support)
542630	O-ring for lid
54860Z	Rubber grommet (Elast-o-vier)
885745	Detector housing with support
885746	Insulation kit, with desiccant packs

Appendix B
Specifications

Results may vary under different operating conditions.

Table B–1. Gauge specifications

Measurement range	Cement: 0–28 PPG Slurry: 0.8–2.8 SGU Proppant concentration: 0–30 lb./prop/added/gal.
Precision	±0.5 to ±0.1 lb./gal. at 8 lb./gal. or ±0.006 to ±0.012 kg/L at 1 kL; dependent on pipe ID, source size, and time constant
Accuracy	±0.1 PPG
Pipe size	Low pressure pipe: 2–10 in. (2.5–25 cm) High pressure pipe: Up to 20,000 psi/1,360.9 atm/1,379 bar
Power requirements	12–24 Vdc, 4 VA
Output	4–20 mA, RS485, RS232
Shock/Vibration	Detector withstands shock of 200 drops onto concrete from 2 m. Drops consistent with 100 in 1 azimuth followed by 100 drops in perpendicular azimuth.
Operating temperature	-58°F to +140°F (-50°C to +60°C)
Housing	Source head: Model 5190/5192 Detector: Stainless steel 316 or carbon steel

Table B–2. SGD-O transmitter specifications

Input	Standard DC power: 12 Vdc (9–15 V), 15 W Optional DC power: 24 Vdc (20–28 V), 12 W Optional AC power: 110/220 Vac (100–240 V), 50/60 Hz, 25 VA
Output	3.8–20.5 mA DC (adjustable operating range). Configurable as isolated, self-powered (standard) or isolated, loop-powered (user supplies 24 Vdc loop power). Maximum load: 700 ohms.
Serial communications	RS232, 1 terminal block
Update rate	4 times per second
Connectors	Amphenol quarter turn bayonet style, Jupiter or military-style cable available; quick disconnect oilfield rugged connectors
Operating temperature	-40°F to +140°F (-40°C to +60°C)
Display	4-line, backlit LCD

Keypad	10 keys, external
Housing	Stainless steel 316
Mounting	Transmitter can be mounted 150 ft. (45.72 m) from the detector

Appendix C
Calibration Tables

Table C–1. 2" to 5.5" pipes: ratios 0.200–0.279

Ratios: 0.200–0.219	Factor	Ratios: 0.220–0.239	Factor	Ratios: 0.240–0.259	Factor	Ratios: 0.260–0.279	Factor
0.200	0.3308	0.220	0.3532	0.240	0.3750	0.260	0.3962
0.201	0.3320	0.221	0.3543	0.241	0.3761	0.261	0.3972
0.202	0.3331	0.222	0.3554	0.242	0.3771	0.262	0.3983
0.203	0.3342	0.223	0.3565	0.243	0.3782	0.263	0.3993
0.204	0.3354	0.224	0.3576	0.244	0.3793	0.264	0.4004
0.205	0.3365	0.225	0.3587	0.245	0.3803	0.265	0.4014
0.206	0.3376	0.226	0.3598	0.246	0.3814	0.266	0.4025
0.207	0.3387	0.227	0.3609	0.247	0.3825	0.267	0.4035
0.208	0.3399	0.228	0.3620	0.248	0.3835	0.268	0.4045
0.209	0.3410	0.229	0.3631	0.249	0.3846	0.269	0.4056
0.210	0.3421	0.230	0.3642	0.250	0.3857	0.270	0.4066
0.211	0.3432	0.231	0.3653	0.251	0.3867	0.271	0.4076
0.212	0.3443	0.232	0.3663	0.252	0.3878	0.272	0.4087
0.213	0.3455	0.233	0.3674	0.253	0.3888	0.273	0.4097
0.214	0.3466	0.234	0.3685	0.254	0.3899	0.274	0.4107
0.215	0.3477	0.235	0.3696	0.255	0.3909	0.275	0.4118
0.216	0.3488	0.236	0.3707	0.256	0.3920	0.276	0.4128
0.217	0.3499	0.237	0.3718	0.257	0.3930	0.277	0.4138
0.218	0.3510	0.238	0.3728	0.258	0.3941	0.278	0.4148
0.219	0.3521	0.239	0.3739	0.259	0.3951	0.279	0.4159

Table C–2. 2" to 5.5" pipes: ratios 0.280–0.399

Ratios: 0.280–0.309	Factor	Ratios: 0.310–0.339	Factor	Ratios: 0.340–0.369	Factor	Ratios: 0.370–0.399	Factor
0.280	0.4169	0.310	0.4471	0.340	0.4764	0.370	0.5049
0.281	0.4179	0.311	0.4481	0.341	0.4774	0.371	0.5059
0.282	0.4189	0.312	0.4491	0.342	0.4783	0.372	0.5068
0.283	0.4200	0.313	0.4501	0.343	0.4793	0.373	0.5077
0.284	0.4210	0.314	0.4511	0.344	0.4803	0.374	0.5087
0.285	0.4220	0.315	0.4520	0.345	0.4812	0.375	0.5096
0.286	0.4230	0.316	0.4530	0.346	0.4822	0.376	0.5105
0.287	0.4240	0.317	0.4540	0.347	0.4831	0.377	0.5115
0.288	0.4250	0.318	0.4550	0.348	0.4841	0.378	0.5124
0.289	0.4261	0.319	0.4560	0.349	0.4850	0.379	0.5133
0.290	0.4271	0.320	0.4570	0.350	0.4860	0.380	0.5143
0.291	0.4281	0.321	0.4579	0.351	0.4870	0.381	0.5152
0.292	0.4291	0.322	0.4589	0.352	0.4879	0.382	0.5161
0.293	0.4301	0.323	0.4599	0.353	0.4889	0.383	0.5170
0.294	0.4311	0.324	0.4609	0.354	0.4898	0.384	0.5180
0.295	0.4321	0.325	0.4619	0.355	0.4908	0.385	0.5189
0.296	0.4331	0.326	0.4628	0.356	0.4917	0.386	0.5198
0.297	0.4341	0.327	0.4638	0.357	0.4927	0.387	0.5208
0.298	0.4351	0.328	0.4648	0.358	0.4936	0.388	0.5217
0.299	0.4361	0.329	0.4658	0.359	0.4946	0.389	0.5226
0.300	0.4371	0.330	0.4667	0.360	0.4955	0.390	0.5235
0.301	0.4381	0.331	0.4677	0.361	0.4964	0.391	0.5244
0.302	0.4391	0.332	0.4687	0.362	0.4974	0.392	0.5254
0.303	0.4401	0.333	0.4696	0.363	0.4983	0.393	0.5263
0.304	0.4411	0.334	0.4706	0.364	0.4993	0.394	0.5272
0.305	0.4421	0.335	0.4716	0.365	0.5002	0.395	0.5281
0.306	0.4431	0.336	0.4726	0.366	0.5012	0.396	0.5290
0.307	0.4441	0.337	0.4735	0.367	0.5021	0.397	0.5300
0.308	0.4451	0.338	0.4745	0.368	0.5030	0.398	0.5309
0.309	0.4461	0.339	0.4754	0.369	0.5040	0.399	0.5318

Table C–3. 2" to 5.5" pipes: ratios 0.400–0.519

Ratios: 0.400–0.429	Factor	Ratios: 0.430–0.459	Factor	Ratios: 0.460–0.489	Factor	Ratios: 0.490–0.519	Factor
0.400	0.5327	0.430	0.5599	0.460	0.5864	0.490	0.6124
0.401	0.5336	0.431	0.5608	0.461	0.5873	0.491	0.6133
0.402	0.5345	0.432	0.5616	0.462	0.5882	0.492	0.6142
0.403	0.5355	0.433	0.5625	0.463	0.5890	0.493	0.6150
0.404	0.5364	0.434	0.5634	0.464	0.5899	0.494	0.6159
0.405	0.5373	0.435	0.5643	0.465	0.5908	0.495	0.6167
0.406	0.5382	0.436	0.5652	0.466	0.5917	0.496	0.6176
0.407	0.5391	0.437	0.5661	0.467	0.5925	0.497	0.6184
0.408	0.5400	0.438	0.5670	0.468	0.5934	0.498	0.6193
0.409	0.5409	0.439	0.5679	0.469	0.5943	0.499	0.6202
0.410	0.5418	0.440	0.5688	0.470	0.5952	0.500	0.6210
0.411	0.5427	0.441	0.5697	0.471	0.5960	0.501	0.6219
0.412	0.5436	0.442	0.5706	0.472	0.5969	0.502	0.6227
0.413	0.5446	0.443	0.5714	0.473	0.5978	0.503	0.6236
0.414	0.5455	0.444	0.5723	0.474	0.5986	0.504	0.6244
0.415	0.5464	0.445	0.5732	0.475	0.5995	0.505	0.6253
0.416	0.5473	0.446	0.5741	0.476	0.6004	0.506	0.6261
0.417	0.5482	0.447	0.5750	0.477	0.6012	0.507	0.6270
0.418	0.5491	0.448	0.5759	0.478	0.6021	0.508	0.6278
0.419	0.5500	0.449	0.5767	0.479	0.6030	0.509	0.6287
0.420	0.5509	0.450	0.5776	0.480	0.6038	0.510	0.6295
0.421	0.5518	0.451	0.5785	0.481	0.6047	0.511	0.6304
0.422	0.5527	0.452	0.5794	0.482	0.6056	0.512	0.6312
0.423	0.5536	0.453	0.5803	0.483	0.6064	0.513	0.6321
0.424	0.5545	0.454	0.5812	0.484	0.6073	0.514	0.6329
0.425	0.5554	0.455	0.5820	0.485	0.6081	0.515	0.6338
0.426	0.5563	0.456	0.5829	0.486	0.6090	0.516	0.6346
0.427	0.5572	0.457	0.5838	0.487	0.6099	0.517	0.6354
0.428	0.5581	0.458	0.5847	0.488	0.6107	0.518	0.6363
0.429	0.5590	0.459	0.5855	0.489	0.6116	0.519	0.6371

Table C–4. 2" to 5.5" pipes: ratios 0.520–0.639

Ratios: 0.520–0.549	Factor	Ratios: 0.550–0.579	Factor	Ratios: 0.580–0.609	Factor	Ratios: 0.610–0.639	Factor
0.520	0.6380	0.550	0.6631	0.580	0.6877	0.610	0.7120
0.521	0.6388	0.551	0.6639	0.581	0.6885	0.611	0.7128
0.522	0.6397	0.552	0.6647	0.582	0.6893	0.612	0.7136
0.523	0.6405	0.553	0.6655	0.583	0.6901	0.613	0.7144
0.524	0.6413	0.554	0.6664	0.584	0.6910	0.614	0.7152
0.525	0.6422	0.555	0.6672	0.585	0.6918	0.615	0.7160
0.526	0.6430	0.556	0.6680	0.586	0.6926	0.616	0.7168
0.527	0.6439	0.557	0.6688	0.587	0.6934	0.617	0.7176
0.528	0.6447	0.558	0.6697	0.588	0.6942	0.618	0.7184
0.529	0.6455	0.559	0.6705	0.589	0.6950	0.619	0.7192
0.530	0.6464	0.560	0.6713	0.590	0.6958	0.620	0.7200
0.531	0.6472	0.561	0.6721	0.591	0.6966	0.621	0.7208
0.532	0.6481	0.562	0.6730	0.592	0.6675	0.622	0.7216
0.533	0.6489	0.563	0.6738	0.593	0.6983	0.623	0.7224
0.534	0.6497	0.564	0.6746	0.594	0.6991	0.624	0.7232
0.535	0.6506	0.565	0.6754	0.595	0.6999	0.625	0.7239
0.536	0.6514	0.566	0.6763	0.596	0.7007	0.626	0.7247
0.537	0.6522	0.567	0.6771	0.597	0.7015	0.627	0.7255
0.538	0.6531	0.568	0.6779	0.598	0.7023	0.628	0.7263
0.539	0.6539	0.569	0.6787	0.599	0.7031	0.629	0.7271
0.540	0.6547	0.570	0.6795	0.600	0.7039	0.630	0.7279
0.541	0.6556	0.571	0.6804	0.601	0.7047	0.631	0.7287
0.542	0.6564	0.572	0.6812	0.602	0.7055	0.632	0.7295
0.543	0.6572	0.573	0.6820	0.603	0.7063	0.633	0.7303
0.544	0.6581	0.574	0.6828	0.604	0.7071	0.634	0.7311
0.545	0.6589	0.575	0.6836	0.605	0.7079	0.635	0.7319
0.546	0.6597	0.576	0.6844	0.606	0.7087	0.636	0.7327
0.547	0.6606	0.577	0.6853	0.607	0.7096	0.637	0.7335
0.548	0.6614	0.578	0.6861	0.608	0.7104	0.638	0.7343
0.549	0.6622	0.579	0.6869	0.609	0.7112	0.639	0.7351

Table C–5. 2" to 5.5" pipes: ratios 0.640–0.759

Ratios: 0.640–0.669	Factor	Ratios: 0.670–0.699	Factor	Ratios: 0.700–0.729	Factor	Ratios: 0.730–0.759	Factor
0.640	0.7358	0.670	0.7594	0.700	0.7826	0.730	0.8055
0.641	0.7366	0.671	0.7602	0.701	0.7834	0.731	0.8062
0.642	0.7374	0.672	0.7609	0.702	0.7841	0.732	0.8070
0.643	0.7382	0.673	0.7617	0.703	0.7849	0.733	0.8078
0.644	0.7390	0.674	0.7625	0.704	0.7857	0.734	0.8085
0.645	0.7398	0.675	0.7633	0.705	0.7864	0.735	0.8093
0.646	0.7406	0.676	0.7640	0.706	0.7872	0.736	0.8100
0.647	0.7414	0.677	0.7648	0.707	0.7880	0.737	0.8108
0.648	0.7422	0.678	0.7656	0.708	0.7887	0.738	0.8115
0.649	0.7429	0.679	0.7664	0.709	0.7895	0.739	0.8123
0.650	0.7437	0.680	0.7672	0.710	0.7903	0.740	0.8131
0.651	0.7445	0.681	0.7679	0.711	0.7910	0.741	0.8138
0.652	0.7453	0.682	0.7687	0.712	0.7918	0.742	0.8146
0.653	0.7461	0.683	0.7695	0.713	0.7926	0.743	0.8153
0.654	0.7469	0.684	0.7703	0.714	0.7933	0.744	0.8161
0.655	0.7477	0.685	0.7710	0.715	0.7941	0.745	0.8168
0.656	0.7484	0.686	0.7718	0.716	0.7948	0.746	0.8176
0.657	0.7492	0.687	0.7726	0.717	0.7956	0.747	0.8183
0.658	0.7500	0.688	0.7733	0.718	0.7964	0.748	0.8191
0.659	0.7508	0.689	0.7741	0.719	0.7971	0.749	0.8198
0.660	0.7516	0.690	0.7749	0.720	0.7979	0.750	0.8206
0.661	0.7524	0.691	0.7757	0.721	0.7987	0.751	0.8213
0.662	0.7531	0.692	0.7764	0.722	0.7994	0.752	0.8221
0.663	0.7539	0.693	0.7772	0.723	0.8002	0.753	0.8228
0.664	0.7547	0.694	0.7780	0.724	0.8009	0.754	0.8236
0.665	0.7555	0.695	0.7787	0.725	0.8017	0.755	0.8244
0.666	0.7563	0.696	0.7795	0.726	0.8025	0.756	0.8251
0.667	0.7570	0.697	0.7803	0.727	0.8032	0.757	0.8259
0.668	0.7578	0.698	0.7811	0.728	0.8040	0.758	0.8266
0.669	0.7586	0.699	0.7818	0.729	0.8047	0.759	0.8273

Table C–6. 2" to 5.5" pipes: ratios 0.760–0.799

Ratios: 0.760–0.769	**Factor**	**Ratios: 0.770–0.779**	**Factor**	**Ratios: 0.780–0.789**	**Factor**	**Ratios: 0.790–0.799**	**Factor**
0.760	0.8281	0.770	0.8356	0.780	0.8430	0.790	0.8504
0.761	0.8288	0.771	0.8363	0.781	0.8438	0.791	0.8512
0.762	0.8296	0.772	0.8371	0.782	0.8445	0.792	0.8519
0.763	0.8303	0.773	0.8378	0.783	0.8452	0.793	0.8526
0.764	0.8311	0.774	0.8386	0.784	0.8460	0.794	0.8534
0.765	0.8318	0.775	0.8393	0.785	0.8467	0.795	0.8541
0.766	0.8326	0.776	0.8400	0.786	0.8475	0.796	0.8549
0.767	0.8333	0.777	0.8408	0.787	0.8482	0.797	0.8556
0.768	0.8341	0.778	0.8415	0.788	0.8489	0.798	0.8563
0.769	0.8348	0.779	0.8423	0.789	0.8497	0.799	0.8571

Table C–7. 6" pipes

Ratios: 0.300–0.329	Factor	Ratios: 0.330–0.359	Factor	Ratios: 0.360–0.389	Factor	Ratios: 0.390–0.419	Factor
0.300	0.4416	0.330	0.4711	0.360	0.4998	0.390	0.5277
0.301	0.4426	0.331	0.4721	0.361	0.5007	0.391	0.5286
0.302	0.4436	0.332	0.4731	0.362	0.5017	0.392	0.5295
0.303	0.4446	0.333	0.4740	0.363	0.5026	0.393	0.5305
0.304	0.4456	0.334	0.4750	0.364	0.5036	0.394	0.5314
0.305	0.4466	0.335	0.4760	0.365	0.5045	0.395	0.5323
0.306	0.4476	0.336	0.4769	0.366	0.5054	0.396	0.5332
0.307	0.4486	0.337	0.4779	0.367	0.5064	0.397	0.5341
0.308	0.4496	0.338	0.4789	0.368	0.5073	0.398	0.5350
0.309	0.4506	0.339	0.4798	0.369	0.5082	0.399	0.5359
0.310	0.4516	0.340	0.4808	0.370	0.5092	0.400	0.5369
0.311	0.4525	0.341	0.4817	0.371	0.5101	0.401	0.5378
0.312	0.4535	0.342	0.4827	0.372	0.5110	0.402	0.5387
0.313	0.4545	0.343	0.4837	0.373	0.5120	0.403	0.5396
0.314	0.4555	0.344	0.4846	0.374	0.5129	0.404	0.5405
0.315	0.4565	0.345	0.4856	0.375	0.5138	0.405	0.5414
0.316	0.4575	0.346	0.4865	0.376	0.5148	0.406	0.5423
0.317	0.4585	0.347	0.4875	0.377	0.5157	0.407	0.5432
0.318	0.4594	0.348	0.4884	0.378	0.5166	0.408	0.5441
0.319	0.4604	0.349	0.4894	0.379	0.5176	0.409	0.5450
0.320	0.4614	0.350	0.4903	0.380	0.5185	0.410	0.5459
0.321	0.4624	0.351	0.4913	0.381	0.5194	0.411	0.5468
0.322	0.4633	0.352	0.4922	0.382	0.5203	0.412	0.5477
0.323	0.4643	0.353	0.4932	0.383	0.5213	0.413	0.5486
0.324	0.4653	0.354	0.4941	0.384	0.5222	0.414	0.5495
0.325	0.4663	0.355	0.4951	0.385	0.5231	0.415	0.5504
0.326	0.4672	0.356	0.4960	0.386	0.5240	0.416	0.5513
0.327	0.4682	0.357	0.4970	0.387	0.5249	0.417	0.5522
0.328	0.4692	0.358	0.4979	0.388	0.5259	0.418	0.5531
0.329	0.4702	0.359	0.4989	0.389	0.5268	0.419	0.5540

Table C–8. 8" pipes

Ratios: 0.200–0.229	Factor	Ratios: 0.230–0.259	Factor	Ratios: 0.260–0.289	Factor	Ratios: 0.290–0.319	Factor
0.200	0.3418	0.230	0.3752	0.260	0.4071	0.290	0.4379
0.201	0.3429	0.231	0.3763	0.261	0.4082	0.291	0.4389
0.202	0.3440	0.232	0.3773	0.262	0.4092	0.292	0.4399
0.203	0.3452	0.233	0.3784	0.263	0.4103	0.293	0.4409
0.204	0.3463	0.234	0.3795	0.264	0.4113	0.294	0.4419
0.205	0.3474	0.235	0.3806	0.265	0.4123	0.295	0.4429
0.206	0.3486	0.236	0.3817	0.266	0.4134	0.296	0.4439
0.207	0.3497	0.237	0.3827	0.267	0.4144	0.297	0.4449
0.208	0.3508	0.238	0.3838	0.268	0.4155	0.298	0.4459
0.209	0.3520	0.239	0.3849	0.269	0.4165	0.299	0.4469
0.210	0.3531	0.240	0.3860	0.270	0.4175	0.300	0.4479
0.211	0.3542	0.241	0.3870	0.271	0.4186	0.301	0.4489
0.212	0.3553	0.242	0.3881	0.272	0.4196	0.302	0.4499
0.213	0.3564	0.243	0.3892	0.273	0.4206	0.303	0.4509
0.214	0.3575	0.244	0.3903	0.274	0.4216	0.304	0.4519
0.215	0.3587	0.245	0.3913	0.275	0.4227	0.305	0.4529
0.216	0.3598	0.246	0.3924	0.276	0.4237	0.306	0.4539
0.217	0.3609	0.247	0.3934	0.277	0.4247	0.307	0.4549
0.218	0.3620	0.248	0.3945	0.278	0.4257	0.308	0.4559
0.219	0.3631	0.249	0.3956	0.279	0.4268	0.309	0.4568
0.220	0.3642	0.250	0.3966	0.280	0.4278	0.310	0.4578
0.221	0.3653	0.251	0.3977	0.281	0.4288	0.311	0.4588
0.222	0.3664	0.252	0.3987	0.282	0.4298	0.312	0.4598
0.223	0.3675	0.253	0.3998	0.283	0.4308	0.313	0.4608
0.224	0.3686	0.254	0.4008	0.284	0.4318	0.314	0.4618
0.225	0.3697	0.255	0.4019	0.285	0.4329	0.315	0.4627
0.226	0.3708	0.256	0.4030	0.286	0.4339	0.316	0.4637
0.227	0.3719	0.257	0.4040	0.287	0.4349	0.317	0.4647
0.228	0.3730	0.258	0.4050	0.288	0.4359	0.318	0.4657
0.229	0.3741	0.259	0.4061	0.289	0.4369	0.319	0.4667

Table C–9. 10" pipes: ratios 0.100–0.219

Ratios: 0.100–0.129	Factor	Ratios: 0.130–0.159	Factor	Ratios: 0.160–0.189	Factor	Ratios: 0.190–0.219	Factor
0.100	0.2154	0.130	0.2565	0.160	0.2946	0.190	0.3304
0.101	0.2168	0.131	0.2578	0.161	0.2958	0.191	0.3315
0.102	0.2182	0.132	0.2591	0.162	0.2971	0.192	0.3327
0.103	0.2196	0.133	0.2605	0.163	0.2983	0.193	0.3338
0.104	0.2211	0.134	0.2618	0.164	0.2995	0.194	0.3350
0.105	0.2225	0.135	0.2631	0.165	0.3007	0.195	0.3361
0.106	0.2239	0.136	0.2644	0.166	0.3019	0.196	0.3373
0.107	0.2253	0.137	0.2656	0.167	0.3031	0.197	0.3384
0.108	0.2267	0.138	0.2669	0.168	0.3043	0.198	0.3396
0.109	0.2281	0.139	0.2682	0.169	0.3055	0.199	0.3407
0.110	0.2295	0.140	0.2695	0.170	0.3058	0.200	0.3419
0.111	0.2309	0.141	0.2708	0.171	0.3080	0.201	0.3430
0.112	0.2323	0.142	0.2721	0.172	0.3092	0.202	0.3441
0.113	0.2336	0.143	0.2733	0.173	0.3104	0.203	0.3453
0.114	0.2350	0.144	0.2746	0.174	0.3115	0.204	0.3464
0.115	0.2364	0.145	0.2759	0.175	0.3127	0.205	0.3475
0.116	0.2378	0.146	0.2772	0.176	0.3139	0.206	0.3487
0.117	0.2391	0.147	0.2784	0.177	0.3151	0.207	0.3498
0.118	0.2405	0.148	0.2797	0.178	0.3163	0.208	0.3509
0.119	0.2418	0.149	0.2809	0.179	0.3175	0.209	0.3520
0.120	0.2432	0.150	0.2822	0.180	0.3187	0.210	0.3532
0.121	0.2445	0.151	0.2835	0.181	0.3198	0.211	0.3543
0.122	0.2459	0.152	0.2847	0.182	0.3210	0.212	0.3554
0.123	0.2472	0.153	0.2859	0.183	0.3222	0.213	0.3565
0.124	0.2486	0.154	0.2872	0.184	0.3234	0.214	0.3576
0.125	0.2499	0.155	0.2884	0.185	0.3245	0.215	0.3587
0.126	0.2512	0.156	0.2897	0.186	0.3257	0.216	0.3598
0.127	0.2526	0.157	0.2909	0.187	0.3269	0.217	0.3610
0.128	0.2539	0.158	0.2921	0.188	0.3280	0.218	0.3621
0.129	0.2552	0.159	0.2934	0.189	0.3292	0.219	0.3632

Table C–10. 10" pipes: ratios 0.220–0.249

Ratios: 0.220–0.229	**Factor**	**Ratios: 0.230–0.239**	**Factor**	**Ratios: 0.240–0.249**	**Factor**
0.220	0.3643	0.230	0.3752	0.240	0.3860
0.221	0.3654	0.231	0.3763	0.241	0.3871
0.222	0.3665	0.232	0.3774	0.242	0.3882
0.223	0.3676	0.233	0.3785	0.243	0.3892
0.224	0.3687	0.234	0.3796	0.244	0.3903
0.225	0.3698	0.235	0.3807	0.245	0.3914
0.226	0.3709	0.236	0.3817	0.246	0.3924
0.227	0.3720	0.237	0.3828	0.247	0.3935
0.228	0.3731	0.238	0.3839	0.248	0.3946
0.229	0.3741	0.239	0.3850	0.249	0.3956

Appendix D
Gauge Calibration Records

Following is a condensed version of the procedure detailed in Chapter 4. It is assumed that the gauge has been installed properly, the shutter is open (if applicable), and the pipe is empty of any fluid.

Date	Gauge	Pipe Size (inches)	Pipe ID (inches)

Step	Description	Command DAC	Location or DAC	Value
1	Erase memory.	74		
2	Load standard oilfield setup.	1016		
3	Enter pipe ID (inches).		048003	
4	Standardize the gauge on air. When complete, fill pipe with clean water. Allow detector to stabilize for five minutes.	121		
5	Calibrate on water.	4		
6	Record the water/air ratio.		118003	
7	Use pipe size and water/air ratio to obtain the factor from the tables (Appendix C). Record the factor.		Calibration tables (in user guide)	
8	Clear "Cal Point Pending" message.	49		
9	Reset CAL/REF ratio to 1.00.		086003	
10	Standardize the gauge on water.	121		
11	Record the water signal value.		128003	
12	Calculate the ZnCl signal value: ZnCl = Water signal * Factor.			
13	Enter the calculated ZnCl signal value.		133003	
14	Hold the output at ZnCl signal value.	137		
15	Displayed density should be near 1.812 g/ml. (Record value.)			
16	Record the slope correction factor.		049003	
17	Record the carrier specific gravity.		085003	
18	Displayed density should be 1.812 g/ml. Adjust slope correction factor if necessary until density is 1.812 g/ml.		049003	
19	Clear all holds.	9		
20	Displayed density should be 1.000 g/ml. (Record value.)			

Completed by: _____

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Appendix E
Commonly Used Parameter & Command DACs

The following tables provide regularly used parameter and command DACs.

Table E–1. Common parameter DACs

Parameter Description	DAC	Notes
Snapshot of detector signal	112003	0 to 65540 corresponds to 0 to10 V input
Standardization value	128003	0 to 65540
Standardization value corrected for source decay	121003	
Snapshot of channel 1	116013	
Snapshot of channel 2	116023	
Time constant	007004	128 seconds (8 seconds recommended)
Slope correction factor (labeled "slope")	049003	1.000
Calibration density	024003	
Top of span (reading at 20 mA) (Solids added / Volume of carrier)	114013	2500 g/L (metric) 30 lb/gal (English)
Bottom of span (reading at 4 mA)	115013	0.00
Pipe internal diameter	048003	inches
Cal/Ref ratio	086003	1.0
Solids density	083003	2.65 g/cm^3
Carrier density	085003	0.9982 g/cm^3
Carrier attenuation coefficient	019003	0.086 cm^2/g
Solids attenuation coefficient	020003	0.077 cm^2/g
Weeks since last reference	054003	
Enable less than 0 and greater than 100%	043030	
Enable phantom measurements (HV control)	045020	

Parameter Description	DAC	Notes
Enable protected memory (DensityPRO)	013010	
Enable protected memory (LevelPRO)	005010	
High voltage hold value	070003	

Table E–2. Common command DACs

Command Description	DAC
Preload configuration for SGD-O oilfield in metric units	1014
Preload configuration for SGD-O oilfield in English units	1016
Hold input at value indicated by parameter 133003	137
Hold current output at 50% (12 mA for a 4–20 mA)	2
Hold current output at maximum (20 mA for 4–20 mA)	5
Hold current output at minimum (4 mA for 4–20 mA)	8
Clear all holds	9
Toggle status message	72
Reset without clearing data	81
Calibration command	80
Erase all entries except comm setup	82
Erase all entries	74
Clear protected data	159
Standardization command	103
Use latest calibration value	49

Appendix F
Toxic & Hazardous Substances Tables

The English and Chinese versions of the Toxic and Hazardous Substances tables are below.

Toxic & Hazardous Substances Table – SGDO

For Chinese Regulation: Administrative Measure on the Control of Pollution Caused by Electronic Information Products

Names and Content of Toxic and Hazardous Substances or Elements

Parts Name	Toxic and Hazardous Substances or Elements (SGDO)					
	Pb	Hg	Cd	Cr6+	PBB	PBDE
Housing	o	o	o	x	o	o
Pre-Amp Board	x	o	o	o	o	o
Pre-Amp Power Board	x	o	o	o	o	o
Cabling	o	o	o	o	o	o

o: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in **SJ/T11363-2006**

x: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in **SJ/T11363-2006**

有毒有害物质名称及含量的标识格式

部件名称	有毒有害物质或元素 (SGDO)					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr6+)	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
外壳	o	o	o	x	o	o
前置放大器电路板	x	o	o	o	o	o
前置放大器电源电路板	x	o	o	o	o	o
缆线连接	o	o	o	o	o	o

o：表示该有毒有害物质在该部件所有均质材料中的含量均在**SJ/T 11363-2006**标准规定的限量要求以下

x: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出**SJ/T 11363-2006**标准规定的限量要求

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Appendix G
Related Technical Bulletins

This appendix provides a list of technical bulletins related to this product as of the release date of this document revision. For the most current bulletins, please go to thermoscientific.com. Enter the product name (SGD-O) as the search term and click the Resources tab.

Table G–1. Technical bulletins

TB #	Title
TB-0416-002	Adjusting Gain Settings for the Thermo Scientific SGD-O FSU Pre-Amp Board
TB-0416-005	Troubleshooting the Thermo Scientific SGD-O FSU Pre-Amp Board
TB-0416-017	Using the Thermo Scientific SGD-O Power Cable for Multiple Applications
TB-0416-018	Transmitter Models Used with the Thermo Scientific SGD-O Density Gauge

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